

Figure 28 Railroad Bridges In Cajon Wash (I-15 Bridge
In The Background)



Figure 29 Railroad Bridge Over Highway 138
(Collapse Expected)

to MMI= VIII shaking intensity zones or are on potentially liquefiable soils. The failure of the Bridge shown in Figure 29 was responsible for much of the access time estimate for repair of I-15, since it blocked Highway 138 from being an immediate detour route for equipment needed for the I-15 repairs.

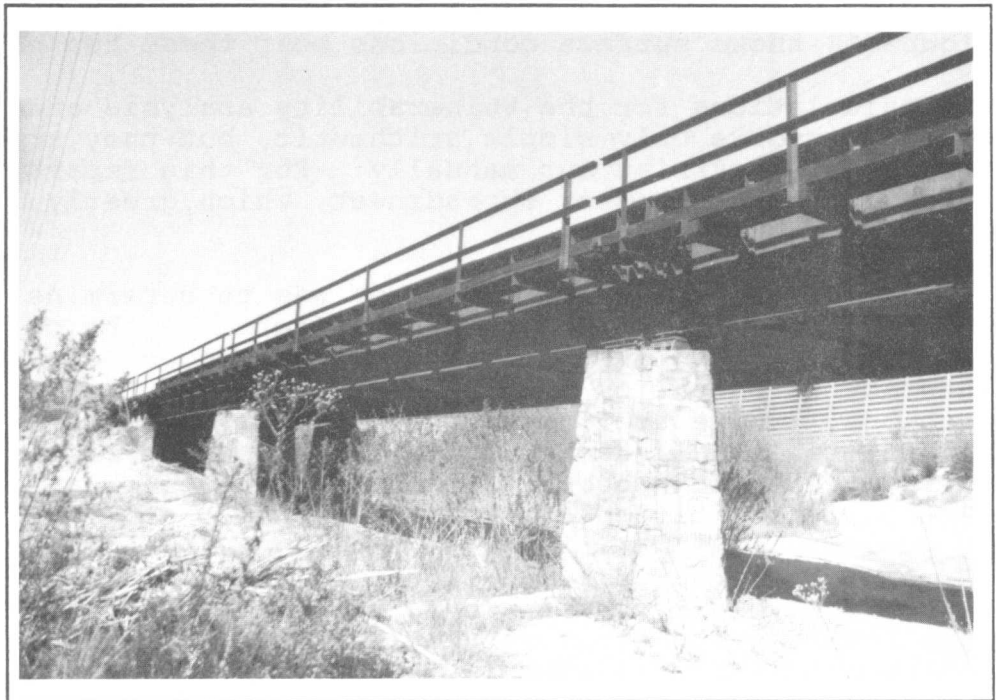


Figure 30 Santa Fe Railroad Rubble Masonry Pier Bridge

There is one bridge on the Santa Fe railroad just south of the I-15 truck weighing station which is founded on rubble masonry piers on sandy soil with a high water table (Figure 30). Loss of one or more spans is anticipated. That is contrasted to the Union Pacific railroad bridge at the

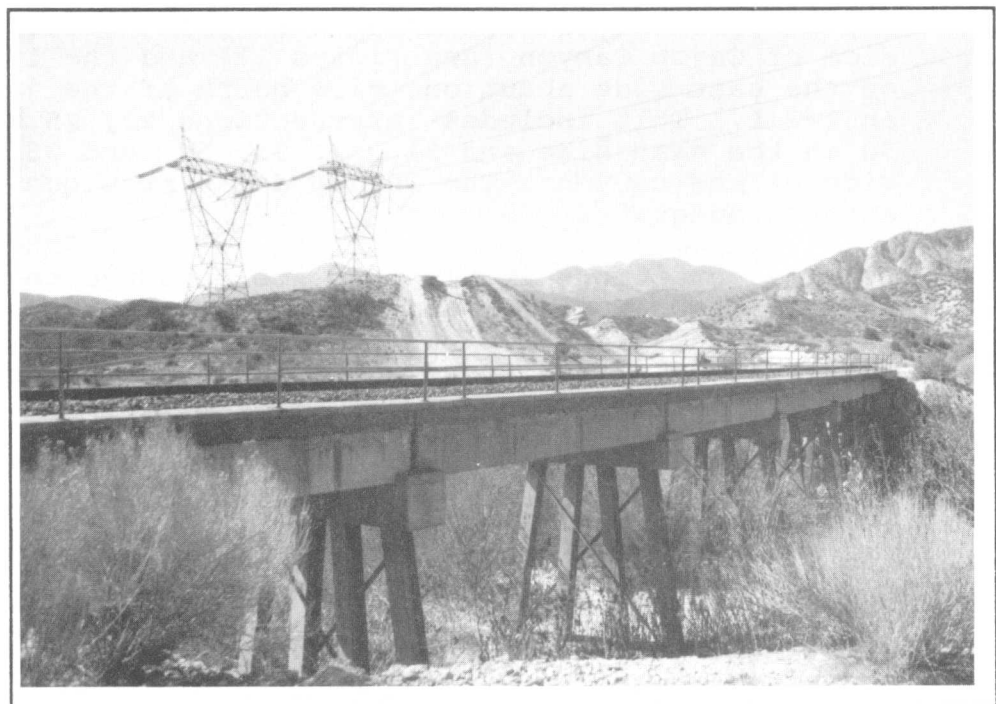


Figure 31 Union Pacific Railroad Bridge With Power Lines Overhead

same location (Figure 31) which has steel column, pile piers. Figure 14 shows surface conditions near these two bridges.

The calculations for the vulnerability analysis and time to restore service involve only simple arithmetic, but they are quite time consuming if carried out manually. For this report, the analyses were done on a computer spreadsheet, which greatly aided an orderly and efficient approach.

The primary objective of the study was to determine how the times to restore full service would be affected by the collocation of several types of lifelines in the same congested corridor. The interaction scenarios have been discussed in this report in earlier sections. There are, however additional problems because of the highway-railroad interactions. For the Cajon Pass application, these interactions occur at the same general areas as the previously identified critical clusters:

- (1) The area near the liquefiable zone just south of the highway I-15 crossing over the railroads and the Cajon Wash, near the junction with I-215. This includes intersection points 8, 9, 10, 11, 13, 14, 15, 16, 18, and 19. A partial collapse of highway bridge No. 54-0818 over the three rail lines adds to the problems at this location. A delay time of 30 days due to this bridge problem (Figure 25) was added to the previously noted 30 day delay due to pipeline damage and hazards.

- (2) The section of the steep slide prone slopes along the west side of Cajon Canyon (see Figure 17) and the liquefiable zone on the east side about one mile north of the junction of I-15 and I-215. This includes intersections 22, 25, 26, 27, 28, 29, 30 on the east side and 31, 32, 33, 34, and 35 on the west side of the canyon. The 30 day delay previously established appears adequate.

- (3) The conditions in Blue Cut are so congested, combined with the expected explosion and/or fire, that an increase in the expected damage states for the railroads by one level is justified. Intersections 38, 39, 93, and 99 are involved. A 60 day delay in access is also assumed.

- (4) At the San Andreas fault zone, intersections 37, 40, 41, and 91 are involved. Problems with fuel pipelines and power lines have already been noted. The 30 day delay in initiating repairs to other lifelines was applied to the railroads.

- (5) The area just north of the section of Highway 138 and west of Highway I-15. Problems with pipelines and power lines have already been noted at intersection points 47, 48, 49, 51, 52, and 53. There is also a possibility of partial collapse of the Southern Pacific railroad bridge over Highway 138 (Figure

29). An additional delay time of 30 days was added for access involving this bridge, over and above the 30 days to clear fire hazards related to pipeline damage.

(6) There are several other minor critical areas:

(a) The area just west and south of the I-15 truck weighing station. The crib retaining wall could slump (see Figure 14). The principle effect is on Southern Pacific railroad sections 15 (westbound) and 24 (eastbound). A 30 day delay was assumed.

(b) Highway Structures 0796, 0797 and 0827 which carry I-15 over the rail lines at Alray and Gish at intersections 55 and 57 (Figure 32). These structures may only be lightly damaged, but a 10 day delay in railroad access is assumed to permit time for inspection and temporary shoring if required.

(c) The I-15 bridge 0664 (Figure 33) over the Southern Pacific tracks north of the pass at intersection 83 is expected to be lightly damaged, but 10 days delay is allowed for inspection (also see Figure 15 which shows details of this bridge).

The effect of these collocation delays on the restoration of the transportation lifelines was evaluated by making a analysis with collocation assumed. This is a "second pass" analysis with the spreadsheet. A special problem developed in reassessment of the alternate route by way of highway 138, in that access to the connection point on the Santa Fe was blocked by the expected partial bridge collapse on the Southern Pacific. For this reason the delay time associated with this problem was added to the previous estimated time to reach the connection point, that is 10 days plus 60 days delay time. This gives 70 days. The cumulative access times for this route were then computed as before, working both ways from this point.

A summary of the results of the study are presented below.

<u>Lifeline</u>	<u>Increase in Probable Time to Restore Service, days</u>	<u>Increase in Probable Time to Restore Service, %</u>
Highway I-15	35	22
Southern Pacific Railroad	17	8
Atcheson Topeka & Santa Fe Railroad	85	33

The smaller percent increase in time to restore service for the Southern Pacific railroad compared to the other transportation lifelines. is due in part to its more favorable location with respect to other lifelines; but it should also be noted that the probable partial collapse of one the bridges on this line contributes to large access time required for the others.

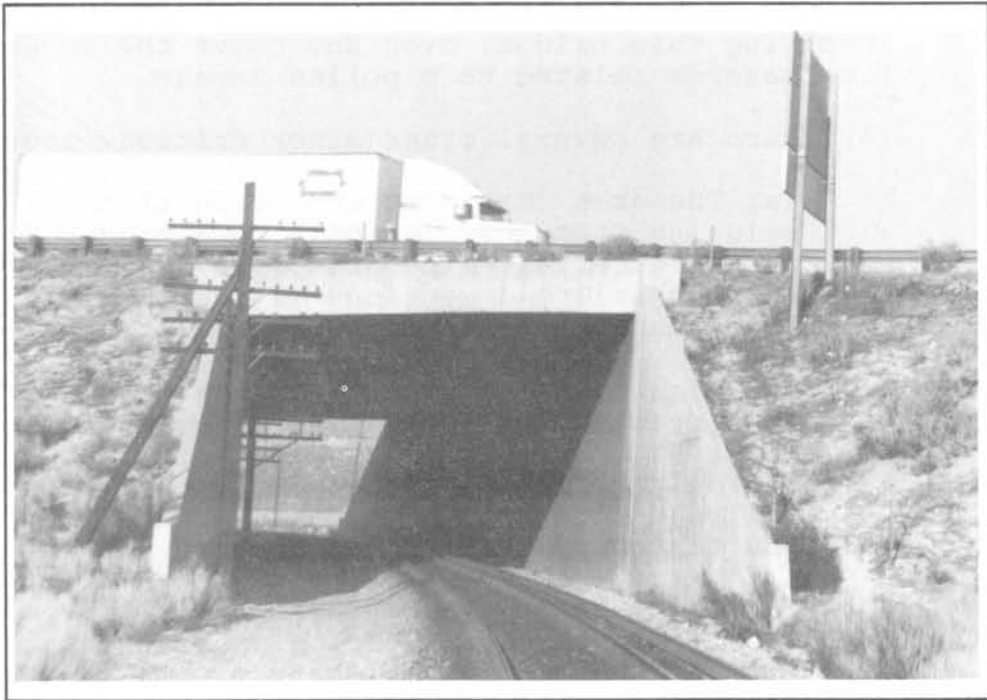


Figure 32 Typical I-15 Box Bridge Over the Railroads



Figure 33 I-15 & Access Road Bridges Over the Southern Pacific Railroad